century, and has been used in determining the orbits of a large number of the minor planets, and of the comets of short period. Oppölzer substitutes for it in his second edition one of his own, which, from extensive application he has found to be much superior to all other methods, both as regards the precision of the results and the rapidity with which the computations may be performed. In the case of the planet *Ceres* he obtained results on a first approximation more exact than those given by the method of Gauss after three approximations. Further, it is pointed out that, where four observations are employed, Gauss's method is not applicable, except when the excentricity is small. There is a chapter on the modifications of Oppölzer's method necessary in the determination of cometary orbits; also a numerical example for the orbit of the minor planet *Eudora*, and one for the first comet of 1866, or the comet of the November meteors, as well as a comparison of the new method with that of Gauss, by an example taken from the *Theoria motûs*. So far, three observations are employed. Similar examples follow for the case of four observations. A succeeding section deals with the calculation of circular orbits, and it is shown that an ephemeris deduced from a circular orbit, which admits of comparatively rapid and easy calculation, may be made of service in following for a time a newly-discovered minor planet. In an appendix are collected all the formulæ usually required in the first determinations of orbits, with reference to those parts of the volume where the analysis and other details are to be found—a *résumé* that possesses great value in so extensive a work. The tables which follow are on a greatly extended and refined system, more especially that for the calculation of the true anomaly in the parabola

The great work of Oppölzer, of which Prof. Pasquier has presented astronomers with so admirable a translation, is not one suited to a beginner; but the student with a certain knowledge of the differential and integral calculus, and of analytical mechanics, may initiate himself with its aid, as the translator remarks in his preface, "à l'un des problèmes les plus hardis que se soit posés l'intelligence humaine."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Silver-Blue Cloudlets again

FROM your last week's issue, p. 264, it would seem that the silver-blue clouds and cloudlets seen at midnight low down over the northern horizon both in this, and last, year's July are attracting much attention among your correspondents; but have not yet had the spectroscope directed to them.

Now there was a remarkable display of those bright blue clouds on the night of Tuesday, July 27, though with some variations on their exact mode of appearance in the *earlier* part of the month; but not necessarily removing them into a different category. The day had been cold but clear, especially in the northern direction, from which the wind was blowing, bar. = 29·60, night temp. = 48° F., depression of wet-bulb = 4°·0 F It was therefore just such a night as at this season of the year and in this high latitude is certain to show a coloured twilight over the sun's place beneath the northern horizon, if ordinary thick fogs, and low cloud-banks do not interfere.

On issuing, then, that night, close upon twelve o'clock, from the Observatory computing-room, upon the Calton Hill, I was surprised and even startled, not at seeing a low-down coloured twilight in the north, but at the excessive strength, and glittering brightness of its colours. You might indeed have, at first sight, imagined that some great city, spread abroad over the plains of Fife was in a fierce state of extensive conflagration, so burning red was the first and lowest stratum extending along nearly 20° of the horizon. But that awful kind of redness passed quickly into lemon-yellow clouds in the stratum next above the red; and then came the silver-blue cloudlets just above the lemon-yellow, and even brighter still; but with an innocence of colour and gentleness of beauty, which at once exorcised the horrid idea of malignant flames devouring the works of man; and showed it must be something very different.

But still what was it, that made that low level strip far away in the north, just then so brilliant in its light and intense in its colours,—that it, and it alone seemed for the time, to be illumining the otherwise pitchy darkness of night? At the same time a few stars were faintly visible; while a long streamer, of apparently white cirrus cloud, trailed over half the sky from west, to east-north-east, and passed across the Polar region at a considerable altitude, having the silver-blue cloudlets and their gorgeous red basement far below, but within, its wide-inclosing sweep.

On reaching home, I got a large spectroscope to bear on the brightest part of the low level streak of richly coloured light, its red, and yellow, and light blue, both collectively, and separately; but with no other decided effect than a short continuous spectrum in the green; which, as I have elsewhere long ago shown, is the spectrum of ordinary twilight always. For even though red and yellow be present to the eye at large, these colours rapidly fade out in any slit-formed spectrum, leaving the maximum of faint twilight placed by the prism as above described.

On this occasion, however, I did remark that that short continuous spectrum began in its citron, or commencing, region rather abruptly: in fact I even imagined a bright line there; and after several independent measures of spectrum-place, duly tested by reference both to a hydrogen tube, and the micrometer readings,—made out, that it was in the very position of the aurora line; or that, in fact, aurora was at that moment assisting, though to a very small extent, in that low streak of merely, but yet so intensely coloured, solar and Scottish, midsummer-midnight, northern, twilight.

Going next to the window, with a hand spectroscope, and examining the long ribbon of supposed white cirrus at some immense elevation,—it was startling as well as delightful to find it to consist of hardly anything but aurora; and to see aurora's chief line thin, sharp and positively brilliant along its whole extent; even appearing, if that could be, several times brighter, than its parent white streamer itself looked to the naked eye.

Nor did the identification, as aurora, of this fair white arc (transverse to a line leading to the magnetic pole), depend on the spectroscope alone: for, about 1 a.m., it began to form luminous, and rather yellowish, abutments to both its western and eastern terminations. Then its original singleness of curvature began to mould itself in the north-west into several curves of shorter radius; and after that, many thin arrows and shafts of light began to shoot out at right-angles from some parts of the great arc, and towards the zenith; and then, after a few minutes, died away. In fact it was to the eye a very fair auroral display, though the papers next morning said nothing about it.

But luminous manifestations were by no means the whole of what the aurora was doing; for presently I could conceal from myself no longer that the whole space below that long and high vaulting, white, upper arc was darkened, as compared against the sky elsewhere, with a brown-black hue; which moreover darkened still further and deepened in obscuration as it descended, until it suddenly ended sharply above, and quite close to, the silver-blue cloudlets of the low coloured twilight on the northern horizon.

Here then was a key at once to the apparently supernatural brilliance of the silver-blue cloudlets and the other colours below them; viz., all the broad expanse of ordinary further,

© 1886 Nature Publishing Group

or outer, twilight, extending in reality to far beyond and above the place of the said cloudlets, was on this occasion painted, or blocked, out by dark dun colour. Nearly half the heavens were so obscured, and the earth below was as dark. No wonder then that the residual strip of untouched twilight shone so conspicuously in contrast.

But what is that darkness below an auroral arc?

It has been compared to the dark space under the negative pole of a highly rarefied gas-tube, when an electric spark is passed through it. And if we add in idea that it extends downwards to a certain angular distance from the sun, say 20°, and keeps to that,—the suggestion may explain why the silver-blue cloudlets were seen higher over the northern horizon in the end of June and beginning of July, than at the end of the latter month; and also why they are never seen in the winter. But a still greater instrumental curiosity manifested itself in this, that the bright auroral citron-coloured line was also given in the spectroscope out of every part of that large expanse of auroral *shade;* and almost, though not quite, as well as from the bright track along its outer and upper edge; just as if, however dark to the unassisted eye, the black-brown space was yet somewhat luminiferous to the peculiar power of the prism.

On the next night after this interesting midnight experience, there was no aurora, and the twilight extended faintly to many degrees higher than the position of the blue clouds of the previous night, and in fact spread into and over the region which was before so decidedly "aurora blackened."

But the next night after that again, viz. two nights after the display, there was a wet drizzling mist which continued through the early hours until more than a quarter of an inch of rainfall had been gathered. Admirably confirming therefore the late Sir Robert Christison's often strongly expressed opinion that 48 hours after a great aurora, abundant rain is sure to follow,—an opinion too which I have only just heard was formed quite independently in Canada by my friend Mr. R. S. Haliburton, who is even now introducing it into his theory of "the aqueous origin of the aurora," so far as that can be carried; but without explaining either the citron line in the spectrum; or the effect on the magnetic needle. C. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, July 31

The Bright Clouds

THE bright cirrus-like clouds are very common here this summer. I have seen them here on the nights of the 12th, 18th, 20th, and 24th of last month, and on the 1st inst., also at Gilsland on the 27th ult., in fact I do not know that in the last fortnight there has been a single night on which the northern sky has been quite free from lower clouds on which they have not appeared more or less; sometimes, however, they appear but for a short time, and in a very limited area of the sky. I have tried to keep a watch to see them in the day-time, but have not succeeded as yet; the nearest approach to success was on the 20th ult., when I saw them as early as 9.22 p.m., at which time they were visible over the greater part of the sky, but in the south-east were not strikingly bright.

There is one peculiarity with respect to them that I have not seen mentioned in NATURE, and that is their motion; on the above dates, except the 20th, I took notice of this, and in every instance the motion was from a northerly or easterly direction, whereas I have not noticed any ordinary cirrus moving from that quarter lately. Last night at from 10 to 10.15, when there were small patches of these curious clouds, there was also at the same time a great deal of ordinary cirrus moving from the west. This circumstance appears to indicate that there is quite a different current of wind in the upper atmosphere from that blowing at the lower elevation of ordinary cirrus.

I have no hesitation in saying that these extraordinary clouds do not shine with their own light, but with the direct light of the sun. T. W. BACKHOUSE

Sunderland, August 2

Aurora

THE following is a record of aurora observed on July 27 at Ramelton, co. Donegal:—

9.30 p.m.—From west to east there were occasional pencils of reddish lights shooting up, while from east to west there were continuous pencils of yellowish and reddish lights, with intermittent clouds and columns of reddish light, rising between the north-east and north-north-west. The pencils were very steady, but increasing and decreasing in length, at times assisted by the clouds of red forming a corona at the zenith round the star Capella (?), at such times as pencils shot up from the southward, on a rude irregular cross. The corona and cross appeared and disappeared quite rapidly. The clouds and columns of reddish light were succeeded by flashes and pencils of bright silver light, they being most frequent and brilliant between the north and west, the flashes being sometimes in long narrow wavy clouds that rapidly ascended, or narrow sheets that appeared and disappeared nearly instantaneously. They became more and more brilliant, especially to the north-north-west, till the display was greatest between 10.30 and 10.45.

10.45 p.m.—About this hour the continuous pencils of yellow and reddish lights between the east and west disappeared with the other lights, but about five minutes afterwards, to the northward, silver pencils and sheets appeared, veering from thence gradually towards the north-east and east. Some of the sheets hung at times in clouds that formed small arcs, that slowly rose obliquely, and moving eastward till about 11 o'clock, when all the lights disappeared, except that at long intervals faint pencils or flashes might shoot up on a small arc of silver clouds; but at 11.25 there was another brilliant display. First there appeared an arch of silver light, its centre being about north-north-west, then two arches that began sending up horns and pencils of light. The upper arch was a little below the North Star, while the lower one went through the Pointers of the Plough; these two arches were succeeded by one at 11.35. The crown of the arch was very unsteady, moving from north to north-north-west and back again, its shape and the accompanying horns and pencils continually changing, the most brilliant and highest pencils being those that shot up to the north-westward. This display continued more or less brilliant till 11.45, when clouds came up and prevented further observations; but at midnight the position of an arch was distinctly defined behind the clouds. At 1 a.m. the clouds had cleared away and no lights were visible. The night was not favourable for seeing an aurora, as it was very light and clear, yet at times the lights were very brilliant. Although the arches were of the same class of silver light as those seen from the North Atlantic or the Canadian Lakes, yet they were not steady like those, as they were continually shifting their positions or disappearing and reappearing. During the previous day there was a northerly wind with at times intensely cold squalls of misty rain.

G. H. KINAHAN

ABOUT 11.15 p.m. July 27, 1886, I observed an incipient stage of the aurora borealis, and about 0.10 a.m. of the 28th a considerable display of auroral colour commenced; but between 0.30 a.m. and 1 there was a vivid display of huge auroral sheets and columns; indeed, it did not require much to entitle the golden scene to the epithet—magnificent. There was a prismatic arc, not unlike a rainbow, which spanned from the north-west to the east, and measured about 70° from its centre to the horizon. All under this arc was a flood of white light, which the aurora did not in the least degree invade. From this arc developed a brilliant aurora borealis to a few degrees south of the zenith; and, with other constellations, Cygnus, Lyra, and the Northern Crown were overwhelmed in a golden flood. In this part of our northern latitude there are at present highly favourable conditions for phenomenal refraction of solar light. On the morning of the 27th and 28th the earth-shine on the moon was very bright, and I have no doubt but that these atmospheric conditions are also favourable to auroral displays. Every vestige of the aurora borealis disappeared about 2.30.

I do not think that an aurora as early as July is on record; in the Culloden meteorological records there is not one recorded so early as July from 1841 to 1880; indeed August is reckoned unusually early for an aurora borealis. I recollect a most magnificent one about the beginning of August in 1882, in the upper reaches of Lanarkshire; the huge vivid sheets and columns reached from the west all along the horizon to the east, and up the vault of heaven to the zenith, and with their fleet shifting flashes and bursts of prismatic coruscations, they lighted up the earth with ineffable glory.

DONALD CAMERON

The Academy, 22, Argyll Street, Paisley, July 28

© 1886 Nature Publishing Group